

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application:

LISTING OF CLAIMS:

1. (previously presented): A transcoding apparatus comprising:
 - a video decoding unit which receives compressed bitstream and performs decoding thereof to output decoded pictures;
 - a complexity estimation unit which estimates complexity of a current picture among the decoded pictures to encode the current picture;
 - a target bit-allocation unit which performs desired bit-allocation using the complexity information of the current picture;
 - a bit-rate control unit which controls bit-rate using bit-allocation information and state information from memory, which outputs an encoded bitstream; and
 - a video encoding unit which encodes the decoded pictures on the basis of the bit-allocation and state information of the bit-rate control unit,wherein the complexity estimation unit calculates complexity of a picture to be currently encoded, using complexity of decoded previous and current pictures output from the video decoding unit and complexity of an encoded previous picture output from the video encoding unit.
2. (original): The transcoding apparatus of claim 1, further comprising an output buffer which stores and outputs pictures encoded by the video encoding unit, wherein state information of the output buffer is provided to the bit-rate control unit.

3. (original): The transcoding apparatus of claim 1, wherein the compressed bitstream input to the video decoding unit is compressed in MPEG (Motion Picture Experts Group) format.

4. (canceled).

5. (original): The transcoding apparatus of claim 1, wherein if it is assumed that $\hat{X}_{out,I}$ represents complexity of a current I picture to be encoded, $\hat{X}_{out,P}$ represents complexity of a current P picture to be encoded, and $\hat{X}_{out,B}$ represents complexity of a current B picture to be encoded, the complexity estimation unit calculates $\hat{X}_{out,I}$, $\hat{X}_{out,P}$, and $\hat{X}_{out,B}$, respectively, as follows:

$$\hat{X}_{out,I} = \frac{X'_{out,I}}{X'_{in,I}} \times X_{in,I}$$

$$\hat{X}_{out,P} = \frac{X'_{out,P}}{X'_{in,P}} \times X_{in,P}$$

$$\hat{X}_{out,B} = \frac{X'_{out,B}}{X'_{in,B}} \times X_{in,B},$$

wherein, $X'_{out,I}$, $X'_{out,P}$, and $X'_{out,B}$ denote complexities of encoded previous pictures of the current I, P, and B pictures, respectively, $X'_{in,I}$, $X'_{in,P}$, and $X'_{in,B}$ denote complexities of

decoded previous pictures of the current I, P, and B pictures, respectively, and $X_{in,I}$, $X_{in,P}$, and

$X_{in,B}$ denote complexities of decoded current I, P, and B pictures, respectively.

6. (original): The transcoding apparatus of claim 1, wherein the bit-allocation unit increases a number of bits to be allocated for the current picture if complexity of an estimated current picture is large, and decreases number of bits to be allocated for the current picture if the complexity of the estimated current picture is small.

7. (original): The transcoding apparatus of claim 1, wherein the target bit-allocation unit calculates a number of bits to be allocated for the current picture using the complexity of the current picture

8. (original): The transcoding apparatus of claim 1, wherein the bit-allocation unit calculates a number of bits T_1 to be allocated for a current I picture, using the complexity of the current picture, as follows:

$$T_I = \frac{\hat{X}_{out,I}}{\hat{X}_{out,I} + \sum_{i=1}^{N_P} \hat{X}_{out,P}[i] + \sum_{j=1}^{N_B} \hat{X}_{out,B}[j]} \times T_{GOP},$$

wherein, \hat{X}_{out} denotes complexity of a picture to be currently encoded, N_P denotes a number of P pictures in a GOP (group of pictures), and N_B denotes a number of B pictures in the GOP.

9. (currently amended): An unit for estimating complexities of pictures, the unit comprising:

a decoded picture information receiving unit which receives complexity information of decoded previous and current pictures;

an encoded picture information receiving unit which receives complexity information of an encoded previous picture generated by encoding the decoded previous picture; and

a complexity estimation unit, which estimates complexity of a picture to be currently encoded, using the complexity of the decoded previous and current pictures and the complexity of the encoded previous picture.

10. (original): The estimating unit of claim 9, wherein the encoded picture is compressed in MPEG format.

11. (original): The estimating unit of claim 9, wherein if it is assumed that $\hat{X}_{out,I}$ represents complexity of a current I picture to be encoded, $\hat{X}_{out,P}$ represents complexity of a current P picture to be encoded, and $\hat{X}_{out,B}$ represents complexity of a current B picture to be encoded, the complexity estimation unit calculates $\hat{X}_{out,I}$, $\hat{X}_{out,P}$, and $\hat{X}_{out,B}$, respectively, as follows:

$$\hat{X}_{out,I} = \frac{X'_{out,I}}{X'_{in,I}} \times X_{in,I}$$

$$\hat{X}_{out,P} = \frac{X'_{out,P}}{X'_{in,P}} \times X_{in,P}$$

$$\hat{X}_{out,B} = \frac{X'_{out,B}}{X'_{in,B}} \times X_{in,B},$$

wherein, $X'_{out,I}$, $X'_{out,P}$, and $X'_{out,B}$ denote complexities of encoded previous pictures of the current I, P, and B pictures, respectively, $X'_{in,I}$, $X'_{in,P}$, and $X'_{in,B}$ denote complexities of decoded previous pictures of the current I, P, and B pictures, respectively, and $X_{in,I}$, $X_{in,P}$, and $X_{in,B}$ denote complexities of decoded current I, P, and B pictures, respectively.

12. (currently amended): A bit-allocation unit comprising:

a complexity estimation unit which receives a compressed bitstream, performs decoding thereof, outputs decoded pictures, and estimates complexity of a current picture among the decoded pictures; and

a bit-allocation unit which performs desired bit-allocation using the complexity of the current picture,

wherein the complexity estimation unit calculates complexity of a picture to be currently encoded, using complexity of a decoded previous and current pictures and complexity of an encoded previous picture generated by encoding one of the output decoded pictures.

13. (original): The bit-allocation unit of claim 12, wherein the compressed bitstream is compressed in MPEG format.

14. (canceled).

15. (original): The bit-allocation unit of claim 12, wherein if it is assumed that $\hat{X}_{out,I}$ represents complexity of a current I picture to be encoded, $\hat{X}_{out,P}$ represents complexity of a current P picture to be encoded, and $\hat{X}_{out,B}$ represents complexity of a current B picture to be encoded, the complexity estimation unit calculates $\hat{X}_{out,I}$, $\hat{X}_{out,P}$, and $\hat{X}_{out,B}$, respectively, as follows:

$$\hat{X}_{out,I} = \frac{X'_{out,I}}{X'_{in,I}} \times X_{in,I}$$

$$\hat{X}_{out,P} = \frac{X'_{out,P}}{X'_{in,P}} \times X_{in,P}$$

$$\hat{X}_{out,B} = \frac{X'_{out,B}}{X'_{in,B}} \times X_{in,B} ,$$

wherein, $X'_{out,I}$, $X'_{out,P}$, and $X'_{out,B}$ denote complexities of encoded previous pictures of the current I, P, and B pictures, respectively, $X'_{in,I}$, $X'_{in,P}$, and $X'_{in,B}$ denote complexities of decoded previous pictures of the current I, P, and B pictures, respectively, and $X_{in,I}$, $X_{in,P}$, and $X_{in,B}$ denote complexities of decoded current I, P, and B pictures, respectively.

16. (original): The bit-allocation unit of claim 12, wherein the target bit-allocation unit calculates a number of bits T_1 to be allocated to a current I picture, using the complexity of the current picture, as follows:

$$T_I = \frac{\hat{X}_{out,I}}{\hat{X}_{out,I} + \sum_{i=1}^{N_P} \hat{X}_{out,P}[i] + \sum_{j=1}^{N_B} \hat{X}_{out,B}[j]} \times T_{GOP},$$

wherein, \hat{X}_{out} denotes complexity of a picture to be currently encoded, N_P denotes a number of P pictures in a GOP (group of pictures), and N_B denotes a number of B pictures in the GOP.

17. (currently amended): A bit-allocation method comprising:

receiving a compressed bitstream, performing decoding thereof, outputting decoded pictures, and estimating complexity of a current picture among the decoded pictures; and

performing desired bit-allocation using the complexity information of the current picture, wherein in estimating the complexity of the current picture, complexity of a picture to be currently encoded is calculated using complexity of decoded previous and current pictures and complexity of an encoded previous picture generated by encoding one of the outputted decoded pictures.

18. (original): The bit-allocation method of claim 17, wherein the compressed bitstream is compressed in MPEG format.

19. (canceled).

20. (original): The bit-allocation method of claim 17, wherein in estimating the complexity of the current picture, if it is assumed that $\hat{X}_{out,I}$ represents complexity of a current I picture to be encoded, $\hat{X}_{out,P}$ represents complexity of a current P picture to be encoded, and $\hat{X}_{out,B}$ represents complexity of a current B picture to be encoded, $\hat{X}_{out,I}$, $\hat{X}_{out,P}$, and $\hat{X}_{out,B}$ are calculated, respectively, as follows:

$$\hat{X}_{out,I} = \frac{X'_{out,I}}{X'_{in,I}} \times X_{in,I}$$

$$\hat{X}_{out,P} = \frac{X'_{out,P}}{X'_{in,P}} \times X_{in,P}$$

$$\hat{X}_{out,B} = \frac{X'_{out,B}}{X'_{in,B}} \times X_{in,B}$$

wherein, $X'_{out,I}$, $X'_{out,P}$, and $X'_{out,B}$ denote complexities of encoded previous pictures of the current I, P, and B pictures, respectively, $X'_{in,I}$, $X'_{in,P}$, and $X'_{in,B}$ denote complexities of decoded previous pictures of the current I, P, and B pictures, respectively, and $X_{in,I}$, $X_{in,P}$, and $X_{in,B}$ denote complexities of decoded current I, P, and B pictures, respectively.

21. (original): The bit-allocation method of claim 17, wherein in performing the desired bit-allocation, a number of bits to be allocated to a current I picture is calculated, using the complexity of the current picture, as follows:

$$T_I = \frac{\hat{X}_{out,I}}{\hat{X}_{out,I} + \sum_{i=1}^{N_P} \hat{X}_{out,P}[i] + \sum_{j=1}^{N_B} \hat{X}_{out,B}[j]} \times T_{GOP},$$

wherein, \hat{X}_{out} denotes complexity of a picture to be currently encoded, N_P denotes a number of P pictures in a GOP (group of pictures), and N_B denotes a number of B pictures in the GOP.

22. (previously presented): A transcoding method comprising:

receiving a compressed bitstream and performing decoding thereof to output decoded pictures;

estimating complexity of a current picture among the decoded pictures;

performing desired bit-allocation using the complexity of the current picture;

controlling bit-rate using bit-allocation information and state information from memory,

which outputs encoded bitstream; and

encoding the decoded pictures on the basis of the bit-allocation and state information,

wherein in estimating the complexity of the current picture, complexity of a picture to be currently encoded is calculated, using complexity of a decoded previous and current pictures, and complexity of an encoded previous picture.

23. (original): The transcoding method of claim 22, wherein the compressed bitstream is compressed in MPEG format.

24. (canceled).

25. (original): The transcoding method of claim 22, wherein in estimating the complexity of the current picture, if it is assumed that $\hat{X}_{out,I}$ represents complexity of a current I picture to be encoded, $\hat{X}_{out,P}$ represents complexity of a current P picture to be encoded, and $\hat{X}_{out,B}$ represents complexity of a current B picture to be encoded, $\hat{X}_{out,I}$, $\hat{X}_{out,P}$, and $\hat{X}_{out,B}$, are calculated respectively, as follows:

$$\hat{X}_{out,I} = \frac{X'_{out,I}}{X'_{in,I}} \times X_{in,I}$$

$$\hat{X}_{out,P} = \frac{X'_{out,P}}{X'_{in,P}} \times X_{in,P}$$

$$\hat{X}_{out,B} = \frac{X'_{out,B}}{X'_{in,B}} \times X_{in,B}$$

wherein, $X'_{out,I}$, $X'_{out,P}$, and $X'_{out,B}$ denote complexities of encoded previous pictures of the current I, P, and B pictures, respectively, $X'_{in,I}$, $X'_{in,P}$, and $X'_{in,B}$ denote complexities of decoded previous pictures of the current I, P, and B pictures, respectively, and $X_{in,I}$, $X_{in,P}$, and $X_{in,B}$ denote complexities of decoded current I, P, and B pictures, respectively.

26. (original): The transcoding method of claim 22, wherein in performing the desired bit-allocation, a number of bits to be allocated to the current picture is increased if the

complexity of the current picture is large, and the number of bits to be allocated to the current picture is decreased if the complexity of the current picture is small.

27. (original): The transcoding method of claim 22, wherein in performing the desired bit-allocation, a number of bits to be allocated to the current picture is estimated using the complexity of the current picture.

28. (original): The transcoding method of claim 22, wherein in performing the desired bit-allocation, a number of bits T_1 to be allocated to a current I picture is calculated, using the complexity of the current picture, as follows:

$$T_I = \frac{\hat{X}_{out,I}}{\hat{X}_{out,I} + \sum_{i=1}^{N_P} \hat{X}_{out,P}[i] + \sum_{j=1}^{N_B} \hat{X}_{out,B}[j]} \times T_{GOP},$$

wherein, \hat{X}_{out} denotes complexity of a picture to be currently encoded, N_P denotes a number of P pictures in a GOP (group of pictures), and N_B denotes a number of B pictures in the GOP.

29. (currently amended): A method for estimating complexities of pictures, the method comprising:

- receiving complexity information of decoded previous and current pictures;
- receiving complexity information of an encoded previous picture; and
- estimating complexity of a current picture to be encoded, using the complexity information of the decoded previous and current pictures and the complexity information of the

encoded previous picture, the encoded previous picture being generated by encoding the decoded previous picture.

30. (original): The complexity estimating method of claim 29, wherein the encoded picture is compressed in MPEG format.

31. (original): The complexity estimating method of claim 29, wherein in estimating the complexity of the current picture, if it is assumed that $\hat{X}_{out,I}$ represents complexity of a current I picture to be encoded, $\hat{X}_{out,P}$ represents complexity of a current P picture to be encoded, and $\hat{X}_{out,B}$ represents complexity of a current B picture to be encoded, $\hat{X}_{out,B}$, $\hat{X}_{out,I}$, and $\hat{X}_{out,B}$, are calculated respectively, as follows:

$$\hat{X}_{out,I} = \frac{X'_{out,I}}{X'_{in,I}} \times X_{in,I}$$

$$\hat{X}_{out,P} = \frac{X'_{out,P}}{X'_{in,P}} \times X_{in,P}$$

$$\hat{X}_{out,B} = \frac{X'_{out,B}}{X'_{in,B}} \times X_{in,B},$$

wherein, $X'_{out,I}$, $X'_{out,P}$, and $X'_{out,B}$ denote complexities of encoded previous pictures of the current I, P, and B pictures, respectively, $X'_{in,I}$, $X'_{in,P}$, and $X'_{in,B}$ denote complexities of

decoded previous pictures of the current I, P, and B pictures, respectively, and $X_{in,I}$, $X_{in,P}$, and

$X_{in,B}$ denote complexities of decoded current I, P, and B pictures, respectively.

32. (currently amended): A computer readable medium having embodied thereon a computer program for enabling a computer to execute a transcoding method, the method comprising:

receiving a compressed bitstream and performing decoding thereof to output decoded pictures;

estimating complexity of a current picture among the decoded pictures using a complexity information of a decoded previous picture, a complexity information of a decoded current picture and a complexity information of an encoded previous picture generated by encoding one of the outputted decoded pictures;

performing desired bit-allocation using the complexity of the current picture;

controlling bit-rate using bit-allocation information and state information from memory, which outputs an encoded bitstream; and

encoding the decoded pictures on the basis of the bit-allocation and state information.

33. (currently amended): A computer readable medium having embodied thereon a computer program for enabling a computer to execute a picture complexity estimation method, the method comprising:

receiving complexity information of decoded previous and current pictures;

receiving complexity information of an encoded previous picture; and

estimating complexity of a current picture to be encoded, using the complexity information of the decoded previous and current pictures and the complexity information of the encoded previous picture generated by encoding the decoded previous picture.

34. (currently amended): A computer readable medium having embodied thereon a computer program for enabling a computer to execute a bit-allocation method, the method comprising:

receiving a compressed bitstream, performing decoding thereof, outputting decoded pictures;

estimating complexity of a current picture among the decoded pictures using a complexity information of a decoded previous picture, a complexity information of a decoded current picture and a complexity information of an encoded previous picture generated by encoding the decoded previous picture; and

performing desired bit-allocation using complexity of the current picture.

35. (previously presented): The transcoding apparatus of claim 1 wherein the complexity estimation unit calculates the complexity of the current picture using information decoded by the video decoding unit and encoded information at a previous time.

36. (previously presented): The transcoding method of claim 22, wherein the complexity of the current picture among the decoded pictures is estimated by calculating the complexity of

the current picture using information obtained by decoding the compressed bitstream and encoded information at a previous time.

37 (previously presented): The transcoding apparatus of claim 1, wherein the complexity estimation unit estimates the complexity of the current picture based on a product of the complexity of the decoded current picture and a ratio of the complexity of the encoded previous picture of the current picture to the complexity of the decoded previous picture of the current picture.

38 (previously presented): The estimating unit of claim 9, wherein the complexity estimation unit estimates the complexity of the current picture based on a product of the complexity of the decoded current picture and a ratio of the complexity of the encoded previous picture of the current picture to the complexity of the decoded previous picture of the current picture.

39. (previously presented): The bit-allocation unit of claim 12, wherein the complexity estimation unit estimates the complexity of the current picture based on a product of the complexity of the decoded current picture and a ratio of the complexity of the encoded previous picture of the current picture to the complexity of the decoded previous picture of the current picture.

40. (previously presented): The bit-allocation method of claim 17, wherein the estimating the complexity of the current picture comprises determining the complexity of the current picture based on a product of the complexity of the decoded current picture and a ratio of the complexity of the encoded previous picture of the current picture to the complexity of the decoded previous picture of the current picture.

41. (previously presented): The transcoding method of claim 22, wherein the estimating complexity of the current pictures comprises determining the complexity of the current picture based on a product of the complexity of the decoded current picture and a ratio of the complexity of the encoded previous picture of the current picture to the complexity of the decoded previous picture of the current picture.

42. (previously presented): The complexity estimating method of claim 29, wherein the estimating the complexity of the current picture to be encoded comprises determining the complexity of the current picture based on a product of the complexity information of the decoded current picture and a ratio of the complexity information of the encoded previous picture to the complexity information of the decoded previous picture.

43. (previously presented): The computer readable medium of claim 32, wherein the estimating the complexity of the current picture comprises determining the complexity of the current picture based on a product of the complexity of the decoded current picture and a ratio of the complexity of the encoded previous picture of the current picture to the complexity of the decoded previous picture of the current picture.

44. (previously presented): The computer readable medium of claim 33, wherein the estimating the complexity of the current picture to be encoded comprises determining the complexity of the current picture based on a product of the complexity information of the decoded current picture and a ratio of the complexity information of the encoded previous picture to the complexity information of the decoded previous picture.

45. (previously presented): The computer readable medium of claim 34, wherein the estimating the complexity of the current picture comprises determining the complexity of the current picture based on a product of the complexity of the decoded current picture and a ratio of the complexity of the encoded previous picture of the current picture to the complexity of the decoded previous picture of the current picture.